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Dated 28 March 2003

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Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
Gwent NP9 1RH

1. Your reference — **GW/MK/8702-GB**

2. Patent application number *(The Patent Office will fill in this part)* — **0205323.9**

3. Full name, address and postcode of the or of each applicant *(underline all surnames)* — **Eugene Ho[illegible]**

   24 Elm Court
   Highburton
   Huddersfield
   HD8 0TB

   [illegible] E701914-5 D00346 P01/7700 0.00-0205323.9

   Patents ADP number *(if you know it)* — 656846300 2

   If the applicant is a corporate body, give the country/state of its incorporation

4. Title of the invention — **Interconnecting Cable**

5. Name of your agent *(if you have one)* — **Bailey Walsh & Co.**

   "Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)* — **5, York Place**
   Leeds
   LS1 2SD

   Patents ADP number *(if you know it)* — **224001**

6. If you are declaring priority from one or more earlier patent applications, give the and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / years)*

7. If this application is divided or otherwise derived from an earlier UK application, the earlier application

Number of earlier application	Date of filing *(day / month / years)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer "Yes" if:* — **NO**

   a) any applicant named in part 3 is not an inventor, or
   b) there is an inventor who is not named as an applicant, or
   c) any named applicant is a corporate body
   See note (d)

9. [illegible] number of sheets for any of the following items you are filing with this form. Do not count copies of the same document.

Continuation sheets of this form	
Description	12
Claim*(s)*	
Abstract	
Drawing*(s)*	5 + 5

10. If you are also filing any of the following, state how many of each item.

Priority Documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(Please specify)*	

11. I/We request the grant of a patent on the basis of this application

Signature

Date

6th March 2002

12. Name and daytime telephone number of person to contact in the United Kingdom

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Notes

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e) *Once you have filled in this form you must remember to sign and date it.*

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Prior Art

CROSSTALK

Figure B

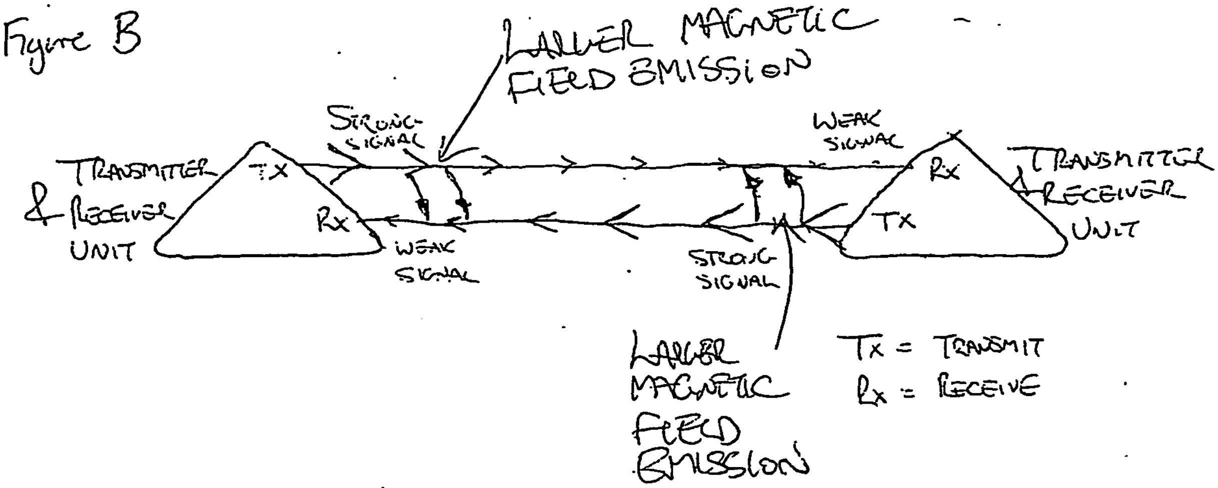
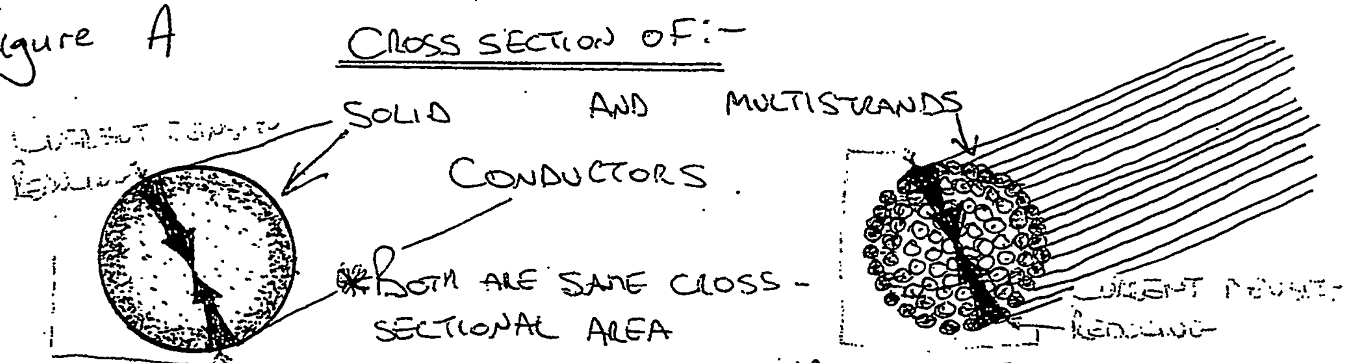


figure A

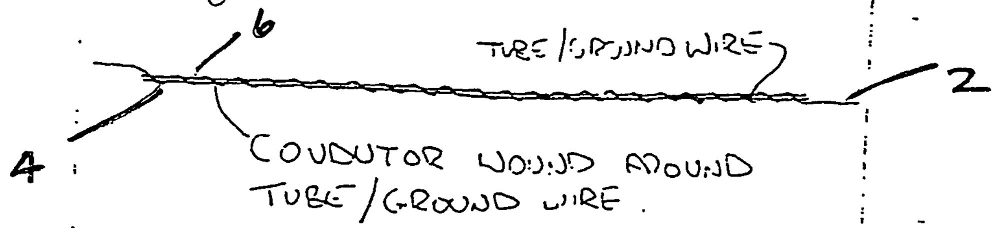
CROSS SECTION OF:-



SOLID CORE CROSS SECTION SHOWING CURRENT DENSITY, HIGHER AROUND PERIMITER OF CONDUCTOR

MULTISTRAND CORE CROSS SECTION SHOWING CURRENT DENSITY HIGHER AROUND PERIMETER OF CONDUCTOR

Figure 1A



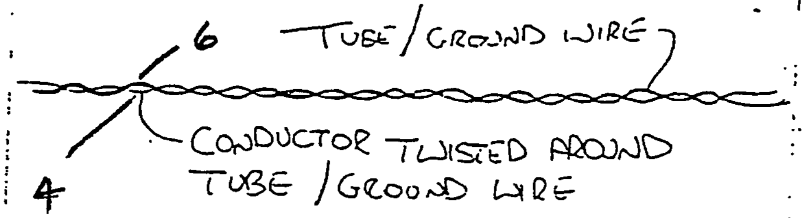


Figure 1B

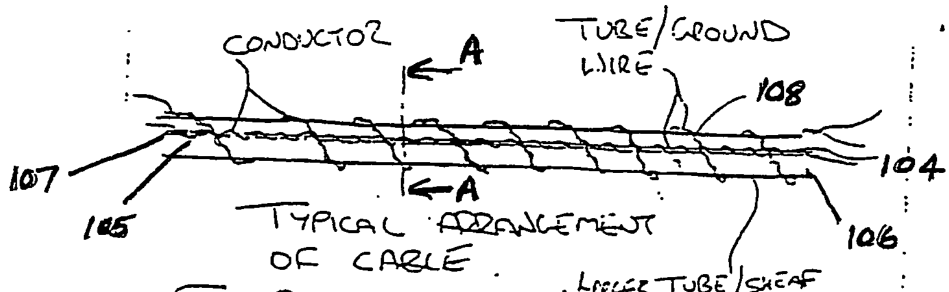


Fig 2A

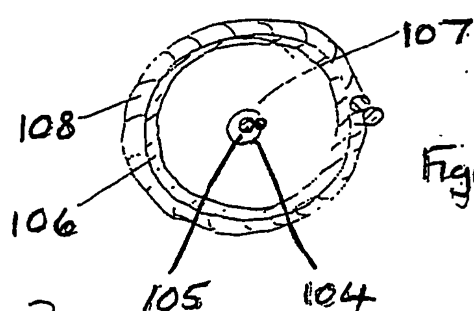


Figure 2B

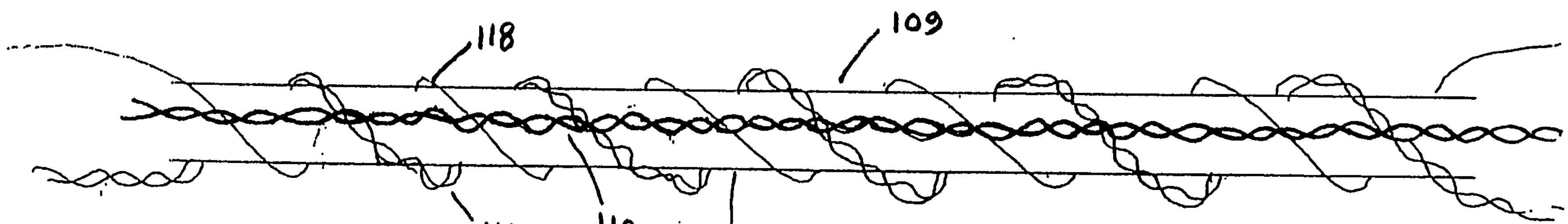


Figure 3A

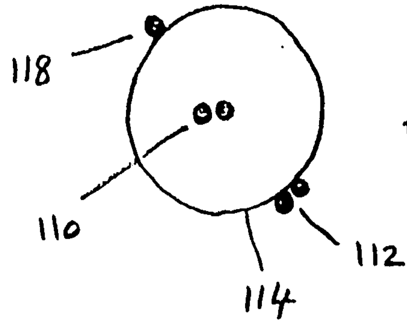


Figure 3B

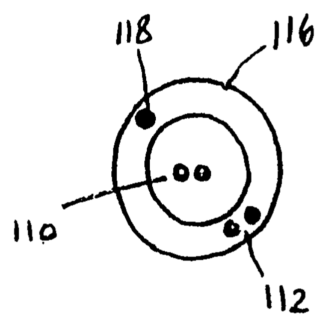


Figure 3C

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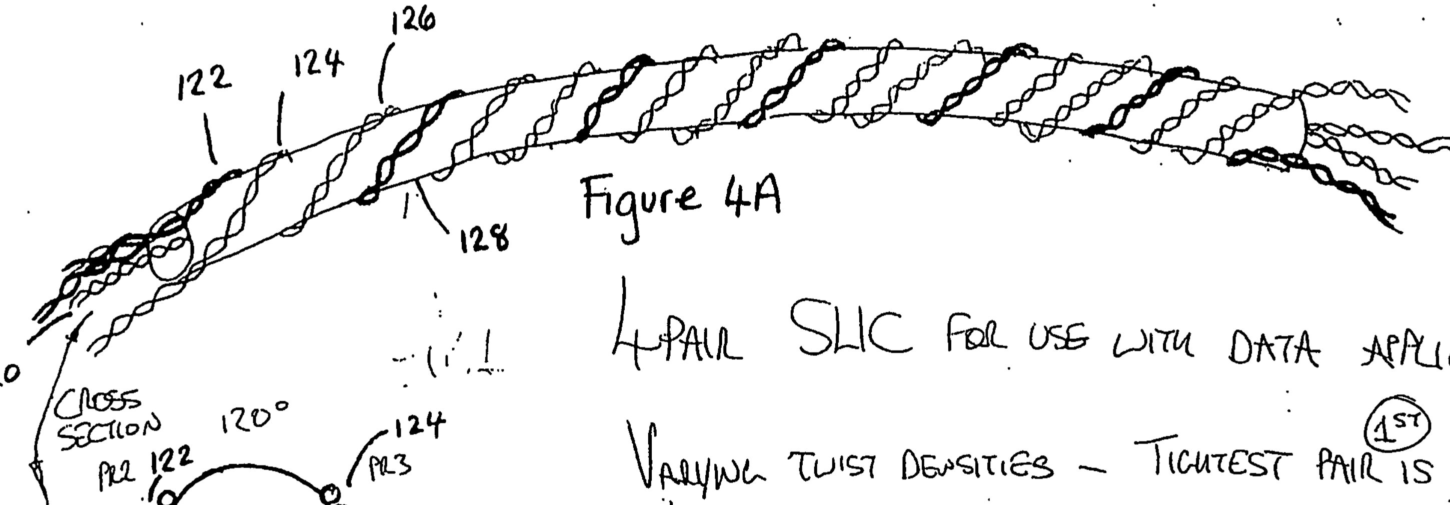

Figure 4A

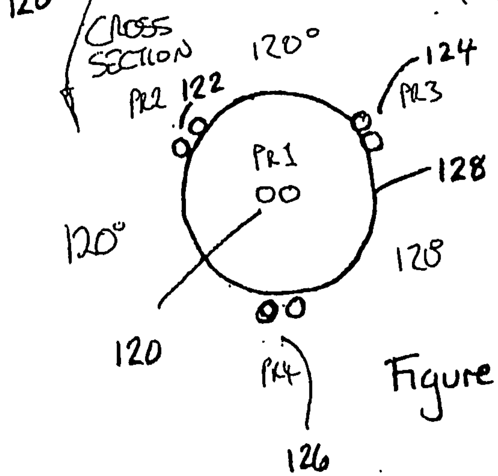

Figure 4B

4-PAIR SLIC FOR USE WITH DATA APPLICATIONS

VARYING TWIST DENSITIES – TIGHTEST PAIR 1ST IS INSIDE THE TUBE/SLEEVE

TWIST LOOSENS FROM PAIR TO PAIR ORBITING THE 1ST PAIR OUTSIDE THE TUBE/SLEEVE

CONFIGURATION GREATLY REDUCES CROSSTALK.

CABLE INNOV

27/07/07 Page

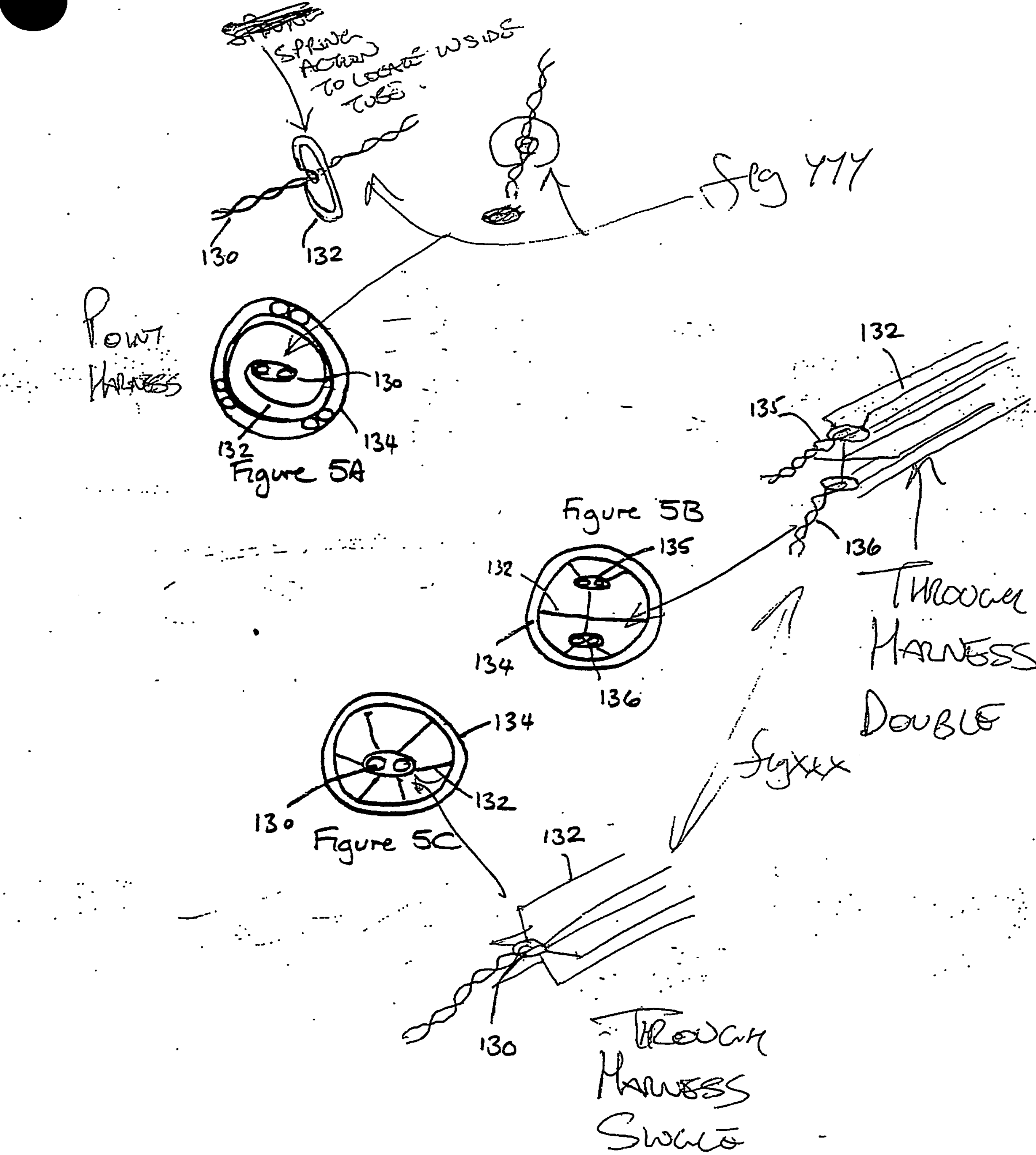

Figure 5A

Figure 5B

Figure 5C

Interconnecting Cable

The present invention which is the subject of this application relates to a formation of conductors and sympathetic conductor sizing and/or conductor shape within a cable to produce a current carrying medium for use in conducting but not exclusively audio, video, power signals and indeed any data transmission, and the connection of data between apparatus such as, but not exclusively, audio components, video, data and electrical components indeed any equipment where an electrical signal line is required. The cable of the invention has been found in tests to reduce distortion and interaction and hence reduce data signal degradation between apparatus and to improve the transmission and efficiency of transmission of electrical signals whether in AC, DC, analogue or digital format.

Another area of use is to improve high speed data transmission.

The invention relates to a formation of the cross section (and purity) of conductors within the cable to produce a data transmission medium which is found to be of advantage in conducting data signals and/or power between electrical apparatus, and associated supplies to the apparatus.

At the present time, conventional cable (which is used to conduct signals between electrical components and provide supplies to the same) has a disadvantage in that typical designs which can consist of single or multiple conductors to act as a transmission line, which are arranged in such a way that it makes them susceptible to distortion in that signals which are carried along the line deteriorate as they pass along the same and hence signal strength and/or other degradations are apparent.

With conventional cable which utilises a solid conductor some signal deterioration can be caused by a physical constant known as "the skin-effect". The "skin-effect" herein described acts to reduce the current density passing along the conductor at distances away from the surface of the conductor as illustrated in Prior Art Figure A. This then leads the currents to tend to crowd towards the surface of the conductor which effectively reduces the "usable" cross sectional area of the conductor and an increase in resistance thus causes degradation in the overall efficiency of the cable. In single conductor or higher current cabling, the cross sectional area of the conductor tends to need to be relatively large e.g. >0.8mm 18 AWG in order to accommodate higher currents therethrough. The increase in the cross-sectional area is proportional to the skin-effect and can lead to a significant factor in the deterioration of signals.

With conventional stranded conductors, the skin-effect problem can still apply if the strands are uninsulated and bundled together to give, in effect, a single conductor with an overall cross-sectional area which is large enough to cause the above problems described with regard to solid core conductors as shown in Prior Art Figure A. When several conductors are used to make up a cable another major problem arises and that is one of magnetic interaction. It is known that when a current is passed through a conductor a magnetic field is set up around it and if this problem is not addressed in the cable design then poor results in terms of accuracy, efficiency and quality occur in terms of error in transmitted data and cross talk between conductor pairs as shown in Prior Art Figure B.

Furthermore, if two or more conductors are provided to run parallel within a cable, each will have a magnetic field set-up around the same and this field can effectively interfere with the

current passing along the other conductor, and vice versa and this problem is experienced and multiplied if further conductors and increase in currents are involved. This problem gives rise to signal conflict along the length of the cable and particularly within audio or video. Higher current signals create greater magnetic fields, damage the smaller current smaller field signals thus distorting and altering the original source signal.

A further problem is that a cable which comprises a series of conductors is susceptible to causing changes e.g. distortion timing etc in the signals which are carried along the same. These changes are caused by magnetic interaction between the conductors. These changes cause the signal at its receiving end to be less than optimum. The sound produced, for example in audio means, can thus be caused to be fuzzy and/or the higher or lower margins of the sound limit which can be produced are not satisfactorily reproduced. In general the larger the bundle of conductors, the larger the problem. To reduce signal degradation it is commonly held that the quantity of conductors should be kept small and therefore many conventional cables attempt to minimize the size of the bundle of conductors to minimise the induction. Furthermore the movement of the strands within the cable can cause points to occur in the cable where distortion is considerably greater than at other points along the length of the cable.

The quality and/or purity of material used in the cables is also regarded as a further method by which the performance of the cable can be increased.

The aim of the present invention is to provide a conductor arrangement which is of a form and manner to overcome the problems as set out previously.

In a first aspect of the invention there is provided a cable which has at least two functional conductors provided therealong wherein each of said conductors is wound or twisted around an elongate member and/or other conductor as they pass along the cable.

In one embodiment the elongate member is a tube or rod of insulating material or another conductor of similar cross sectional area. Each conductor and elongate member configuration effectively forms a transmission line in the cable.

Typically the conductors used are insulated and the cross sectional area is variable according to specific requirements and chosen to give optimum conductivity thereby further increasing the effectiveness.

In one embodiment each conductor is wound or twisted around the outside of an elongate member as it passes there along to form a transmission line. With respect to some applications e.g. data, each transmission time can allow the passage of data in both directions.

In one preferred embodiment a circular (but not exclusively) tube is required of adequate size to house the first transmission line which runs along the inside of the tube and a second transmission line is wound around, either tightly or loosely (or both) the outside of the tube to form the transmission line. This therefore means that for one length of cable, the second transmission line is typically longer in length than the first transmission line as it is wound around a larger diameter elongate member, in the form of the tube. In one embodiment the second transmission line may itself be wound around an

elongate member which may have a diameter similar to that of the conductor; to form a transmission line or core and this, in turn, is wound around the outside of the tube. Typically the second conductor is of higher resistivity than the first conductor due to its increased length, although the inner pair may be of tighter twist density than the outer transmission lines, thereby reducing or eliminating the length differential.

In one embodiment the interior of the tube is provided with location points or a central locator that runs through the length of the cable to locate the first inner transmission line therein and therealong.

In one arrangement the elongate members and/or tube used for winding the conductor are formed of insulating material, either solid or hollow.

In one embodiment, rather than the elongate members being formed from an insulating material, they can be formed of a conducting material in either solid or hollow form to act as a ground wire conductor and/or former solid or hollow where a non-shielded cable is permissible for application.

In whichever embodiment, if a shielded cable is required a metal braided sleeve can be passed over the finished product or the individual conduct or transmission lines as shielding the cable can reduce external R.F noise, increase mechanical strength and the like.

Each conductor referred to herein may in fact comprise a series of wires wound together to form one of said transmission line and preferably each of said transmission lines if it comprises a

number of conductors will have conductors which are wound and/or twisted.

In a second aspect of the invention there is provided a cable having at least one conductor for use in the transfer of data between two locations, the cable comprising a series of conductors selectively grouped together wherein said conductors are provided in twisted or wound sets of two or more conductors, each set forming a transmission line and in each set the conductors are wound around the other conductors in said set.

Typically, the tightness of twist of the conductor around each other conductor in the set is constant in that set. In one embodiment the tightness of twist differs from set to set in a stepped fashion from a tightest twist in a first set to a loosest twist in the last set.

Typically each of said sets comprises two conductors and are wound and/or twisted around each other along the length of the cable conductor.

In one embodiment at least one set is mounted within an elongate member to pass therealong and one or more sets are wound around the outer surface of said elongate member to pass therealong.

In one embodiment the cable conductor comprises four, or more, sets of cores, each set comprising two cores twisted/wound around each other and each of the sets twisted/wound around the others to form a cable conductor.

Typically each of the said cores is insulated from the other by insulating material and the cable, once formed, is again housed with insulating material.

It has been found that the above arrangement of conductors, when used as a conducting cable allows greater bandwidth, less cross talk, reduced induction, capacitance, resistance etc which, reduces the distortion of sound or video reproduction components and from the power supply to each. Similarly, beneficial effect has been found when the same is used to connect high speed data networks, hubs etc and it is envisaged that these further beneficial effects will be found when this form of core arrangement is used in a cable whenever the same is used.

Typically when the cable conductor is used to connect e.g. hi-fi components, positive and negative input and output connectors are required and this may be achieved by providing two separate cables to increase quality.

The insulating material for the conductor elongate member and/or tube used is specific to the application and any insulating material, including specialist materials, can be used. Further shielding in the form of braided, foil or other sleeving placed over the entire cable or individual conductors will act to reduce external RF interference and increase mechanical strength.

Specific embodiments of the invention will now be described with reference to the accompanying drawings wherein:-

Figures 1A and 1B indicate embodiments of the invention with one core provided with an elongate member in the form of a tube or ground wire to form a conductor;

Figures 2A and 2B illustrate an arrangement of two conductors and one tube and/or ground wire;

Figures 3A-C illustrate a further embodiment of the invention;

Figures 4A-B illustrate a yet further embodiment; and

Figures 5A-C illustrate a cross section of the cable in several embodiments.

Referring firstly to Figure 1A there is illustrated a first embodiment of a conductor. This comprises a conductor 4 wound around an insulating elongate member 6 which is shown, in this embodiment, to be straight with the conductor 4 wound in a spiral fashion along the length of the member 6. In this embodiment, the elongate member is formed of insulating material and therefore acts as an insulator but it should be appreciated that the same could be formed of a conducting material whether insulated or not and thereby act as a ground wire if required for certain instances. In any case this shows one form of transmission line or core in accordance with the invention. The density/frequency of the windings can vary to suit specific performance requirements.

Figure 1B illustrates another arrangement whereby the conductor 4 is twisted in conjunction with the elongate member 6 as shown to form a twisted conductor.

Turning now to Figures 2A and 2B there is illustrated a preferred embodiment of an interconnecting cable according to the invention. There is provided an elongate member 105 and along the said member is wound a first conductor 104 to form a

first transmission line 107 which is shown in a wound manner similar to that of Figure 1A. The transmission line 107 is placed inside a tube 106 of insulating material. Around the external wall of the tube 106 there is wound a second transmission core 108 formed in accordance, in this example, with the embodiment shown in Figure 1A. Thus the insulating tube 106 acts to physically separate the two transmission cores 107, 108 of the cable. Yet further it is preferred but not exclusively that the two conductors are wound around their respective elongate members in opposite ways such that, for example the conductor 104 is wound clockwise and the conductor of core 108 is wound anticlockwise respectively. This serves to ensure that any interference created from each of the conductors is directed away from the other conductor thereby reducing the risk of cross-interference. Furthermore, it is preferable that the space between respective conductor windings is different between the two conductors thereby again minimising the risk of cross-interference.

Figure 2B illustrates in cross section along line A – A, of Figure 2A, the arrangements of the components of the interconnecting cable of Figure 2A.

The frequency of the wind or twist may also be varied to allow optimum performance in specific areas and, if required, additional conductors may be used and twisted around if it is required that the cable carry larger currents. The use of a large diameter tube as indicated in Figure 2 allows one of the conductors to be pulled through the inside and twisted there around with the other wound around the external wall and this constant change in the direction of the two conductors as shown in Figure 2 creates an effective reduction in the magnetic interaction between the two conductors thereby improving the

quality of signal transmission by reducing the interference acting on the same.

Referring to Figures 3A-C, there is illustrated a cable 109 for audio, video and higher current applications. The conductors or transmission lines 110, 112 each include two conductors/insulators which are twisted or wound together. In one embodiment, though not exclusively, the twists will be at varying densities to each other. Typically, the twists of each transmission line 110, 112 will typically be constant. The transmission lines carry at least one current carrying conductor (ccc), depending on application. If two ccc's are required then it may be preferable to have the ccc wound around an insulated tube rather than twisted together either clockwise or anti-clockwise in respect to the elongate member. Typically, the arrangement, as shown in Fig. 3A-C, will constitute one current carrying cable although in some applications where there are two ccc's in a pair, all four conductors will make up a pair of ccc's i.e. Positive and Negative D.C. (Direct Current) applications - Phase and Neutral in A.C. (Alternating Current) applications. In any arrangement the signal can be discrete or analogous with respect to time. In Figure 3B the outer transmission line 112 is mounted externally of the elongate member 114 and in practise would be enclosed by an outer housing (not shown). In Figure 3C the outer transmission line 112 is enclosed within a housing 116 which acts as the outer housing and elongate member. In both embodiments a ground wire 118 is incorporated.

A four transmission line arrangement is required for data transmission and illustrated in Figures 4A-B. Typically, in this arrangement, all eight conductors are provided in the form of 4 transmission lines 120, 122, 124, 126 and each conducts and receives information.

Here, the transmission lines are current carrying conductors arranged as figure 4A. The twisting of the conductors will generally have varying densities. The "inner" transmission line 120 will be the tightest and the other transmission lines have less dense twist in comparison. The three transmission lines 122, 124, 126 are spiralled around the tube 128 which acts as a housing for 120 and as a 'former' for the other pairs to orbit. Each pair typically, though not exclusively, is set at (in this arrangement) 120 degrees from each other as per the cross section of Figure 4B. If more or less transmission lines are required then it is preferred that these be positioned equally distant from each other.

In Figures 5B-C there is illustrated how the inner transmission line 130 can be located by a support member 132 within the elongate member 134. This can also allow the cable to house more than one transmission line 135, 136 as shown in Figure 5B, located inside and, in Figures 5B and 5C, along, the elongate member.

As well as the conducting material (quality and purity) the insulating material will have an effect upon performance of the design. In the case of the conductors, substances formed by slow extrusion process utilising low oxygen content, high purity material will perform better than faster extruded, higher oxygen content, lower purity substances. All conducting material types and shapes and sizes e.g. circular, square, triangular etc. in cross section may be used.

If the cable is to be used for high current and or voltage applications then the Cross Sectional Area of the cable will be greatly increased from that of signal cables where the 'skin-

effect' becomes an issue in terms of power loss. The idea of using more than one conductor in this arrangement to make up a 'cable' will reduce this effect from current single core types.

The above description therefore indicates the basis of the current patent application with regard to the overall geometry of the cable. It is also known that the type and purity of materials chosen are important factors and the dielectric materials selected can be used to suit specific needs and requirements and equally, the termination point plugs for connecting the cable to the electrical equipment can be provided to suit the specific equipment and use of cable.

Use of the cable has been found to greatly reduce interference and therefore signal loss of electrical components and to reduce the distortion caused between the cable conductors. It should also be appreciated that the drawings show a single conductor cable but multi conductor cables can be formed using multiples of conductor cable preferably all in accordance with the invention, as required..

Finally, it should be appreciated that the invention herein described is of advantage when used in the transmission of any electrical signals, whether analogue, digital, AC or DC and for a whole range of uses.